

RARE AQUATIC INSECTS, OR HOW VALUABLE ARE BUGS?

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ABSTRACT.— Insects are an important element in the analysis of aquatic ecosystems, (1) because the limited dispersal abilities of many aquatic species means that they must make a living under existing conditions, and (2) because they are often sensitive to slight changes in water and stream quality, thus making excellent indicators of the physical and chemical conditions in a system. Examples of rare, ecologically sensitive species are presented from the Plecoptera, Ephemeroptera, and Trichoptera. Detailed studies of rare aquatic insect species should produce important information on critical habitats that will be useful in the protection of endangered and threatened species in other groups of animals and plants.

I use the term *rare* instead of *endangered* or *threatened*, because no aquatic insects are presently on the United States list of endangered fauna. The term is still relative, though, because my experience indicates that nearly every species can be plentiful if sought at the right place at the right time.

Aquatic insects are useful to anyone studying aquatic habitats because they usually meet two criteria that are essential in assessing aquatic systems. First, they often have very limited dispersal abilities, which means that they must stay and make a living under existing conditions. Second, they are often sensitive to slight changes in water quality, so their presence or absence tells something about the physical and chemical conditions in the system.

Because the conditions present in a given habitat determine which species can live there, these organisms become living indicators of water quality in aquatic ecosystems. If these organisms are invertebrates which exist at low levels in the food web, this is an advantage. Invertebrates are easier to study than are larger animals, because they are more abundant and usually do not carry the emotional stigma associated with large vertebrates. They can also indicate adverse habitat problems sooner, so that adjustments can be made in water or stream quality before the top carnivores are severely affected.

During my studies of aquatic insects in western North America, I have found that

the distribution patterns of certain species fit nicely with a model of island biogeography. Many stoneflies (Plecoptera) are mostly restricted to pristine habitats characterized by cold, clean continuously flowing streams at high elevations or in special spring-fed habitats. It thus follows that if the particular habitat in which they occur is threatened, then they almost automatically become rare and may become extinct. Such species populations are often considered relicts of faunas that were once more prevalent when more ideal conditions occurred.

Studies on the stonefly genus *Amphinemura* (Baumann and Gaufin 1972, Bauman 1976) showed that it was a Palearctic genus that had extended into the Neotropical Realm and was still present in western North America in limited relictual populations. Although four species showed fairly wide distribution patterns in the United States and Mexico, three species were restricted to a single mountain range. *Amphinemura apache* occurred in the Chiricahua Mountains of Arizona, *A. reinerti*, was limited to Sierra Potosí, Mexico, and *A. puebla* was found in a mountain drainage near Veracruz, Mexico.

These *Amphinemura* species are poor fliers and almost need a water connection for dispersal. They live only in small streams that flow all year around and are of high quality. Their distribution patterns closely follow the spruce-fir and high pine forests in the southwestern United States and Mexico. They are

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thus good indicators of a special aquatic habitat in western North America.

Another example of restricted distribution in the stoneflies is *Capnia lacustra* Jewett, which only occurs in Lake Tahoe. It carries on its entire life cycle under water at depths of 100–400 feet (Jewett 1963, 1965). Only one other similar stonefly is known, and that is the genus *Baikaloperla* (Zapekina-Dulkeit and Zhiltzova 1973), in Lake Baikal, Siberia. It is also wingless and possesses similar morphological and ecological traits. It is not surprising that these two deep, ancient lakes contain similar rare species which evolved under specialized conditions and will be lost if their habitat is destroyed.

Much attention has been given to several fish species that occur in the Colorado River drainage such as the Humpback Chub, Razorback Sucker, and Colorado River Squawfish. These fish developed through time in another type of specialized habitat that excluded the salmonids and allowed other taxa to radiate into the open niches. Invertebrate species have also developed under similar conditions and several forms also occur in the Colorado River drainage. Edmunds (1976) lists several mayfly species which are rare and restricted to the Colorado River drainage and similar large warm rivers in western North America.

The following are a few examples of rare mayfly species and an indication of where they occur in the United States: *Anaetris eximia*, Green River; *Lachlania saskatchewanensis*, Green, Colorado, and White Rivers; *Anepeorus rusticus*, Green River; *Homeoneuria* sp. Escalante and Colorado Rivers. These invertebrate species provide additional evidence that our large, warm, western rivers contain animal species that have adapted to special conditions critical for their survival.

Caddisflies or the Trichoptera are interesting insects that occur in a wide variety of aquatic habitats. Most are good fliers and distribute freely, but many species are restricted to a certain habitat because of the larval requirements.

Wiggins (1977) published an outstanding work that makes it possible for any trained biologist to classify caddisfly larvae to genus. Thus it provides another tool for evaluating habitats using aquatic insects. A few inter-

esting examples and their special habitat requirements are: *Goriella baumannii*, organic ooze in spring seeps; *Psychronia costalis*, small meadow streams above 8,000 feet; *Desmona bethula*, small spring streams.

The number of rare aquatic insects is quite large because of the number of different aquatic habitats available and the ability of insects to fit into relatively small niches within those habitats. This is actually a positive value, however, because it allows the researcher to more closely understand the ecosystem since it can be divided into smaller parts.

Two final examples of rare insects that have very specific habitat requirements are the net-winged midges and the water penny beetles.

Net-winged midges are flies which have become adapted to living in torrenticolous habitats. The larvae are greatly modified into chitonlike organisms that attach themselves to the substrate by sucking discs. They live only in clean, cold, well-aerated waters which have a stable, smooth-grained substrate. Thus they can be excellent indicators of these habitat conditions that occur at falls and quick-flowing mountain torrents. Hogue (1973) lists several Blephariceridae species that are presently known only from a single locality or mountain range. This is not simply an artifact of incomplete collecting, but a result of poor adult dispersal ability plus the very specialized habitat requirements of the larvae noted earlier.

Water penny beetles have an adult stage that looks like a terrestrial beetle but a larval stage that is highly modified for life on the bottom of streams. The larva is greatly flattened so that the head and appendages are completely hidden under the thoracic and abdominal sclerites. The single eastern species *Psephenus herricki* is rather widely distributed, but the five known western species have very restricted distributions (Brown and Murvosh 1974). Two species, *P. montanus* (White Mountains, Arizona) and *P. arizonensis* (Chiricahua Mountains, Arizona) have very limited areas of occurrence. An interesting note is that this type of limited distribution pattern is also exhibited by several species in the Plecoptera, Trichoptera, and Ephemeroptera.

Many more examples of "rare" aquatic insects could be given which probably fit into the endangered or threatened categories as presently understood. They are exciting to me for pure scientific studies of zoogeography and phylogeny. However, I feel that the real value is not simply to say "I found another rare creature," but instead to make us more sensitive about the critical habitat conditions which produced these rare species.

Insects tend to be more abundant and are thus easier to study without affecting population dynamics. They are also usually more economical and easier to sample because they are less mobile and can be effectively studied by fewer people with less sophisticated equipment.

On the other hand, politicians and business people may question the value of an insect. Who cares about bugs? How much is a bug really worth?

This problem can be illustrated by an incident with which I was involved while at the Smithsonian Institution. Soon after my arrival in Washington, D.C., I was asked to look through the aquatic insects for which I was responsible as curator and add any species to a list of organisms that could be considered both rare and restricted to the Chesapeake Bay area. In Ross and Ricker (1971) I found a stonefly species, *Allocapnia zekia*, that was known only from the Zekiah Swamp, La Plata, Charles County, Maryland. I added it to the list and forgot about it. About three years later, I received a telephone call from a man who wanted to know all about the "Zekiah Stonefly." At first I did not know what he was talking about, but when he mentioned the Chesapeake Bay species list, I remembered. I did some quick research and indicated that the species was based on a single, male holotype and might possibly be a synonym of a widespread eastern species. He nearly exploded when I reported this to him, because, he said, that "Zekiah Stonefly" was holding up the construction of a water plant in a nearby community and was costing a lot of people a lot of time and money.

In summary, it is important to understand our special environmental problems here in North America. If this can be better facilitated by using aquatic insects, then we

should place renewed emphasis on studies of them. We must, however, be aware of the fact that people in general do not understand the scientific value of insects and might react poorly to "bugs" being used to justify the preservation and conservation of special ecosystems. However, scientific investigations of high quality must utilize all possible avenues of investigation if problems are to be solved with a minimum expenditure of time, effort, and resources.

It is also important that we do not attempt to overstate the value of "rare" species as habitat indicators. Some states, for example, have placed entire orders such as the Plecoptera (stoneflies) and Ephemeroptera (mayflies) on lists or proclamations and have diluted their value. When this is done it becomes difficult to study these organisms, because of the problem involved in obtaining permits and permission to collect specimens. Collecting alone will probably never seriously harm an aquatic insect population, as has occurred with many butterfly species, but habitat manipulation will.

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